15th IAS

International Sedimentological Congress

Excursion A 6

Tectonic evolution during the Alpine cycle. Sedimentation and erosion related to capture of endorheic fluvial systems.

Field Leaders:

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Field Trip Guidebook

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TECTONIC EVOLUTION DURING THE ALPINE CYCLE. SEDIMENTATION AND EROSION RELATED TO CAPTURE OF ENDORHEIC FLUVIAL SYSTEMS.

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INTRODUCTION

The Duero Basin is the largest Cainozoic basin in Spain with a surface area of almost 55.000 km^2. It occupies the major part of the north-west Iberian Peninsula.

High-relief mountains composed of igneous and metamorphic rocks of Paleozoic age (mainly to the west) and siliciclastic and carbonated rocks of Mesozoic age (mainly to the east) bound the basin (Fig. la). These borders formed during the Alpine Orogeny and played an important role in the stratigraphic evolution of the basin.

The Late-Hercynian structure of north-western Spain strongly influenced the structure of the Duero Basin. The main structural lineaments of the basement reacted under the new tectonic conditions imposed by the Alpine Orogeny, but new fault lines also appeared. However, the borders of the basin tended to evolve independently, and this fact is clear in the sedimentary record of the Duero Basin, as we will see during this field-trip. It is necessary therefore to deal, at least briefly, with the structural features of the basin borders before describing the sedimentary record.

The Duero Basin borders

The structure of the present northern mountain boundary consists of low-angle thrusts (Alonso *et al.*, 1996). These thrusts moved several kilometres towards the south, over the Duero Basin fill. They must be backthrusts related to the subduction zone further north, where the Cantabrian Sea moved under the Iberian Plate (Boillot, 1984; Boillot & Malod, 1988). Sediments ranging from Upper Cretaceous to Oligocene in age are affected by these thrusts. They show syntectonic folding (progressive unconformities, *sensu* Riba, 1976, or cumulative wedging systems). Vertical movements dominated the late stage of Alpine deformation. Sediments related to this stage range from Neogene to Present day in age. They onlap previous folds and faults and their dip decreases upward.

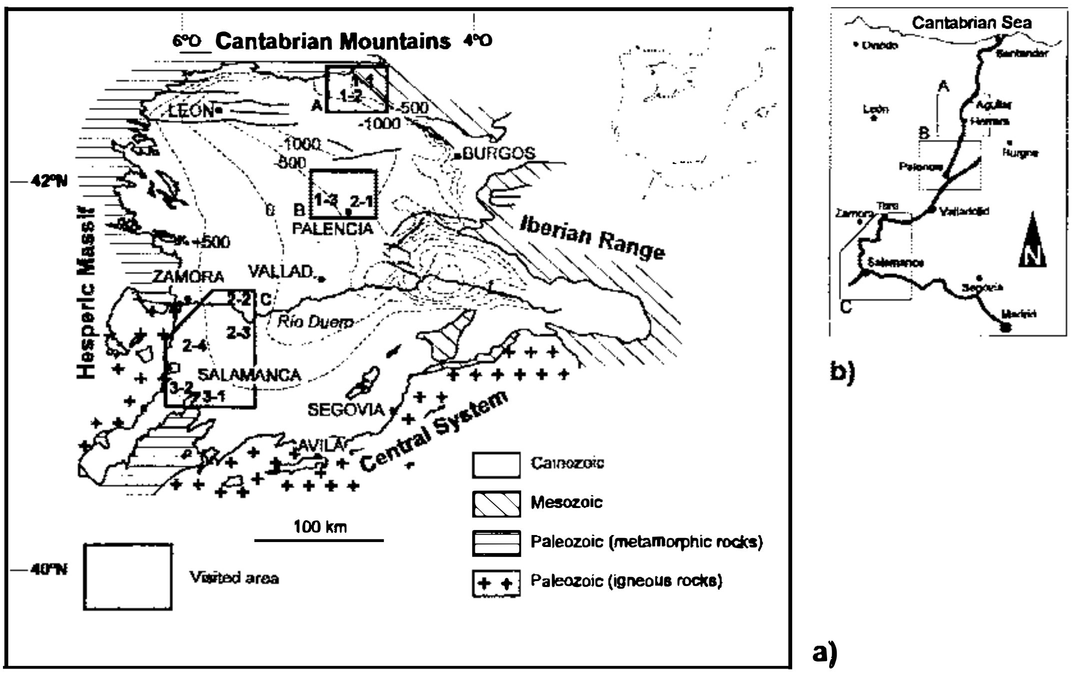

Fig. 1.- Geological (a) and geographical (b) location of the field trip.

The eastern border is a tectonic massif bounded by reverse faults with small horizontal displacements. Sediments affected by these faults range from Cretaceous to Oligocene in age. Neogene sediments onlap the earlier strucures.

Most of the southern boundary consists of reverse faults that affect Mesozoic and Paleogene sediments. Fault surfaces are relatively vertical in outcrop, but the fault dips decrease with depth. Neogene sediments onlap this border and they are increasengly affected by normal and strike-slip faults to the west.

The western border has had a weaker activity. Some north to north-east trending faults that played an important role during the Mesozoic in relation to the opening of the North-Atlantic Ocean prolonged their activity during the Cainozoic modifying the configuration of the basin. Sediments range from Upper Cretaceous to Recent in age and all of them onlap this border.

The tectonic record of the internal parts of the Duero Basin is much poorer because Paleogene sediments do not crop out thus, the record is limited to Neogene times. Here, the movements of basement faults decrease upwards and are hardly apparent at the surface. The only effect of the largest faults was to produce differential subsidence or to induce families of small faults.

The sedimentary record

Santisteban *et al.*, (1996a) have divided the sedimentary record of the Duero Basin in three tectonosedimentary complexes (TSCs), composed, in their turn, of several tectosedimentary units (TSUs, sensu Megías, 1982) bounded by unconformities of tectonic or climatic origin (Fig. 2). Each one of these complexes relates to a stage of tectonic evolution of the basin and they developed under particular climatic conditions that determined its overall mineralogical composition:

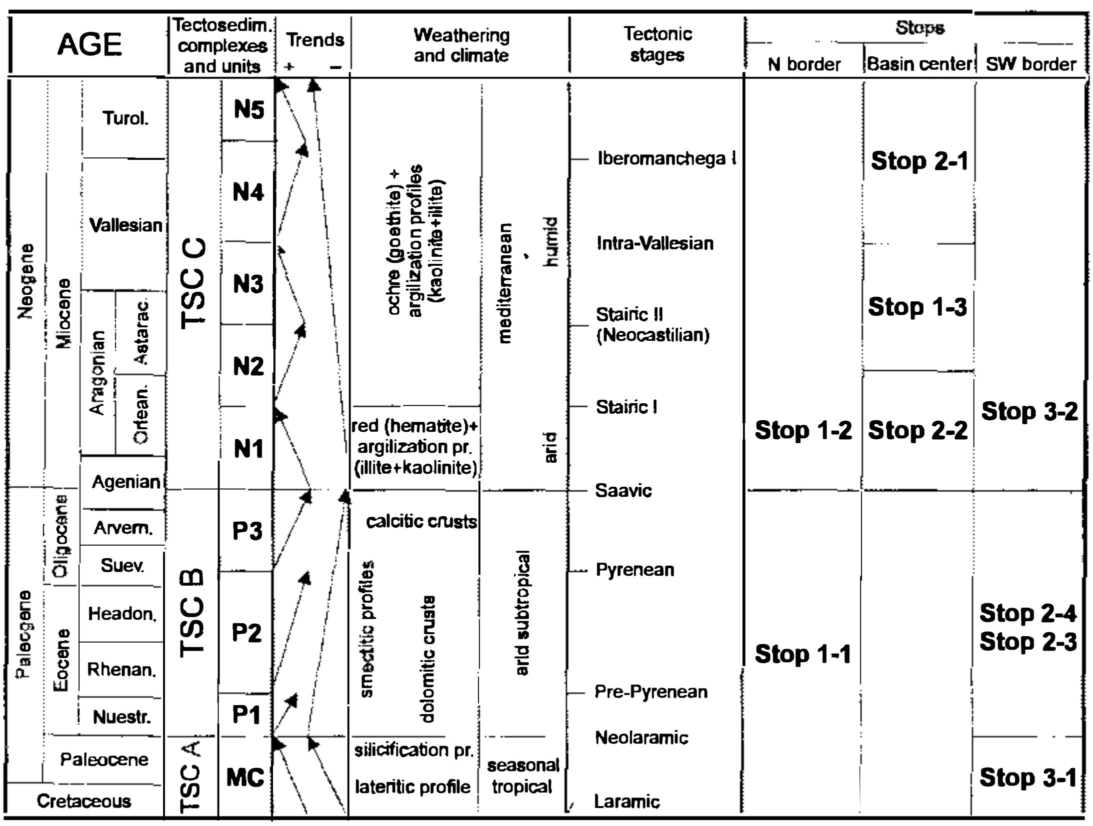

Fig. 2.- Tectosedimentary complexes and units of the Duero Basin: their chronological position, climate and weathering profiles related to them, hounding tectonic events and chronological situation of stops.

TSC A, also refered as the 'preorogenic complex', is of Upper Cretaceous to Paleocene age. This unit consists of siliciclastic, carbonated and evaporitic deposits arranged in a fining-upwards (FU) sequence that records the end of the Mesozoic extensional regime. Outcrops occur only in some areas along the margins of the basin, but they are not continuous laterally due to intense faulting. There are also outcrops in down-thrown fault blocks of the mountains surrounding the basin. The deposits of TSC A usually occur in stratigraphical continuity with the Upper Cretaceous in the north, east and south-east borders. In other places (west and south-west borders) they rest unconformably upon a thick lateritic weathering profile that affects the Paleozoic basement and acted as source area for the TSC A sediments so they are of siderolithic nature. In these places, the rocks forming TSC A underwent a strong episode of silicification that increased towards the top. Both weathering profiles and sediment composition indicate a tropical climate for this period similar to that of the Cretaceous. This TSC is interpretated as having been deposited in environments ranging from terrestrial (towards the west) to marine (towards the east); this pattern still reflects the Late Mesozoic palaeogeography.

TSC B, also refered as the 'synorogenic complex', is Eocene to Oligocene in age. It consists of mainly siliciclastic sediments with scarce carbonates (except in the south-east corner of the basin where carbonates reach considerable thickness). These sediments form a generally coarsening-upwards (CU) sequence that records the uplift of the basin borders under a compressive regime, which was due to the convergence of the Iberian and European plates. During this time preservation of weathering profiles was very poor and the sediments are mineralogically inmature (mainly arkoses, lithic arkoses and polimictic sediments). An arid subtropical climate can be infered from mineralogical composition of the sediments, paleosoils and fossil remains (Jiménez, 1974; Jiménez *et al.*, 1983). The deposits of TSC B form a fringe near the borders of the basin, where they rest unconformably upon both rocks of the TSC A and the pre-Tertiary basement. Most of the deposits of TSC B were laid down in terrestrial environments (alluvial fan, fluvial); marine deposits occur only in the basin of Villarcayo, in the north-east corner (Montes *et al.*, 1989).

TSC C, also refered as 'postorogenic complex' (not implying lack of tectonic activity), is of Miocene to Recent age. It consists of siliciclastic, carbonate and evaporitic deposits that form a fining-upwards (FU) sequence that records a new extensional stage with adjustment of the relief. It is best represented in the center and north-eastern parts of the basin, covering the previous deposits. TSC C consists of several TSUs which progressivelly onlap previous units and the borders. These rocks formed in terrestrial environments (alluvial fan, fluvial and lacustrine), which filled a basin with a shape roughly similar to present Duero Basin. Tectonic stability favoured the development of weathering profiles during the deposition of TSC C, both in the basin margins and the borders. These profiles reveal a shift from arid (towards the bottom of the TSC C) to humid (towards the top) mediterranean climate.

Gravel sheets previous to the fluvial incision (the so-called *raña*, plural *rañas*) covered large areas of the Hesperic Massif, the borders of the basin, and large areas of the basin. Many authors have considered these deposits as having time significance, but we must stress that they lack specific chronological meaning because 'raña' has formed in the basin in a diachronous way (Martín-Serrano, 1991; Mediavilla *et al.*, 1996; Santisteban *et al.*, 1996b) since the end of the

TSC B. In addition to this diachronic development of incision, the regional variations in subsidence and incision rates allowed the coexistence of incision and aggradation in the Duero Basin.

The **main goals** of this field-trip are to show:

a) how tectonics controlled the overall trend of each TSC while their disposition reflects the particular tectonic behaviour of each border;

b) how tectonics, in areas far away from basin borders (basin center), is recorded in the evolution of the sedimentary systems.

c) how tectonic lateral variations controlled the coeval development of incision and aggradation regimes into the basin by means of tectonic highs and differential subsidence,

d) how climate, which can be masked by the source area of sediments, imprints a particular signature in each TSC, and

e) how incision developed in a diachronous way.

Accordingly to these points, the field-trip is focused in three geographical areas (Fig. 1):

A) The **northern border** of the basin, where we'll see TSCs A, B and C disposition in relation to a highly active mountain front.

B) The **basin center**, where we'll be able to show how sediments of TSC C record tectonic movements and we'll see the first incised deposits in this area (N5 TSU of Turolian age).

C) The **south-west border**, where we'll see how TSCs A, B and C rest upon a less active border, so climate imprint is well-preserved in TSCs sediments. In addition, we'll see how the incision started earlier (Oligocene-Lower Miocene) in this area.

DAY 1

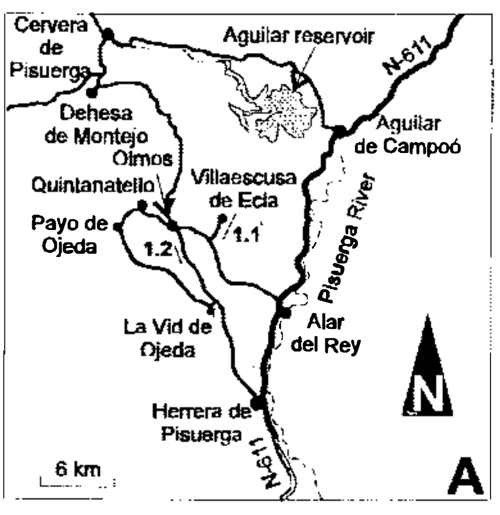

Fig. 3.- Geographical location of stops in the borthern basin border.

A) The northern border: Tectonics in fast-moving borders is a major control that mask the climate imprint on sediments by means of constant rejuvenescence of source area. So, its stratigraphical signal marks the sedimentary succession.

TSCs are characterized by homogeneous lithological composition. They are bounded by tectonic unconformities (discordances) and their trends and geometrical disposition record different stages in the border evolution.

Stop 1-1. Road cut in Villaescusa de Eclas (Fig.

3). Here we'll see the disposition of TSC A and B deposits in relation to a highly active sierra front (Fig. 4).

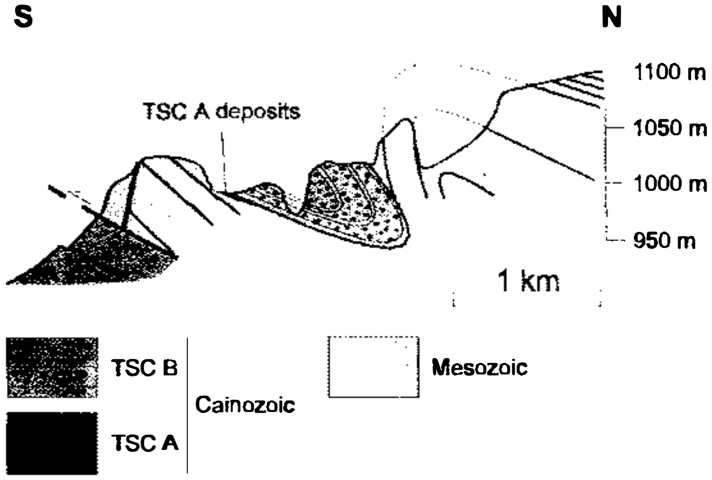

Fig. 4.- Geological section near Villaescusa de Ecla showing relations and geometrical disposition of Mesozoic and A and B TSCs.

a) Southward to the town of Villaescusa de Ecla, TSC A deposits seems to rest concordantly upon Maastrichtian clays and dolostones. However, the sudden change to alluvial conglomerates and the cartographic trace of their boundary suggest a low-dip discordance.

TSC A sediments at this point are polymictic couglomerates (limestone and quartzite clasts) cemented by carbonate. They arrange in tabular to lens-shaped beds of metric thickness and alluvial origin. As a whole, the beds show a parallel disposition that is result of low uplift rates.

TSC B are named as "Facies de las Cuevas" (Mabesoone, 1961) or "Complejo de las Cuevas" (Colmenero *et al.*, 1982). Its sediments are polymictic conglomerates (limestone and quartzite clasts) cemented by carbonate that alternate with red clayey sandy beds. They rest discordantly (angular discordance) upon TSC A sediments and there is no change in the composition or depositional setting of the sediments. This continuity in sediment characteristics, despite the angular discordance, is interpretated as result of the homogeneous nature of their source area (mainly composed by Mesozoic carbonates), their proximity to it (few hundreds of metres), and the fast-moving nature of this border (which is responsible of high erosion rates so "fresh" sediment was always supplied to the nearer accumulation areas).

b) Northwards Villaescusa de Ecla, sediments of TSC B rest discordantly upon Mesozoic deposits (mainly carbonates). TSC B sediments are similar to those described in paragraph a) but in this cross-section we can see:

1) how the dip of the beds progressively decreases to the south (towards the basin center) forming a synsedimentary fold ("progressive discordance" *sensu* Riba, 1976), and

2) how, in the same direction, sandy red beds decrease in their number and thickness so the sequence is topped mainly by conglomerate beds.

Both characteristics record a progressive increase of uplift rates and shortening simultaneous to sedimentation of TSC B.

Stop 1-2. Proximities of Quintanatello (Fig. 3). Disposition and characteristics of TSC C sediments in relation to the northern border of the basin.

From the neigbourhood of Payo the Ojeda, we can observe how the sediments of the TSC C overlay discordantly those of TSC B (Fig. 5). TSC B deposits show synsedimentary folds similar to those observed at Stop 1-1.

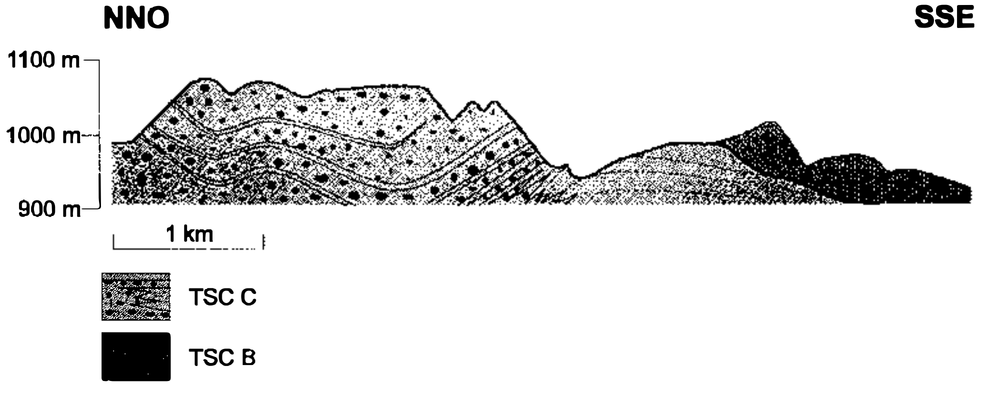

Fig. 5.- Quintanatello geological cross-section. Relations and geometrical disposition of B and C TSCs.

TSC C sediments rest discordantly upon those of TSC B. The angle of TSC C sediments, on the contrary TSC B, decreases progressively upwards as they onlap previous sediments. This disposition reveals a decelerated movement of the faults so sedimentation rates overcome subsidence rate and they bury the previous deposits and the sierra front.

TSC C sediments at this point are polymictic conglomerates in tabular or channelized bodies and red clays and, occasionally, sandstones. These deposits are interpretated as middle reachs of alluvial fans (López *et al.*, 1997). The similarity in composition between these deposits and those of TSC B is due, as explained in the previous stop for TSC A and B, to the proximity to the source area and the high erosion rates. Westwards, sediments of TSC C are ochre-coloured as they come from metamorphic source areas.

B) Basin center: TSC C in the basin center splits in several units bounded by sedimentary breaks related to tectonics. Tectonics is also recorded in the sedimentary succesion by means of sequence trends but with some differences to its record at basin borders. Here, where we cannot see the unit disposition upon the borders and grain size trends are more obscure, tectonics is mostly recorded by patterns of migration of environments (sequences). Lateral relations of these sequences reveal depocenter shifts that are related to subsidence pulses.

In addition, the last TSU (N5) that composes TSC C is the first incided unit in this area.

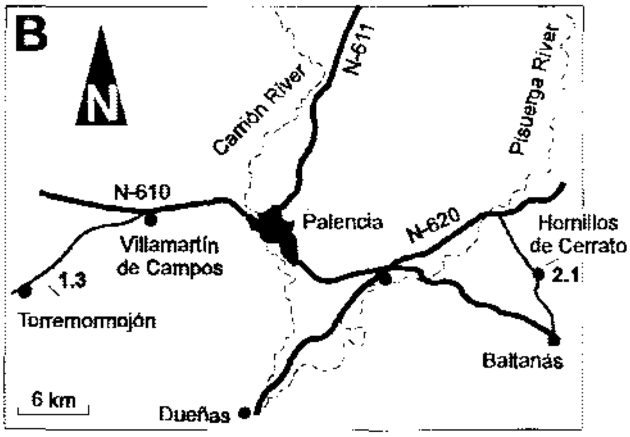

Fig. 6.- Geographical location of stops in the basin center.

Stop 1-3. The visited section locates to the East of Torremormojón (N.T. M., Sheet 311) at Lambert coordinates X: 512.900, Y: 818.000, Z: 785 m (Fig. 6). At this location, we will see the sequential arrangement of N3 and N4 TSU sediments.

N3 and N4 TSU sediments are very similar: 1) Sands and clays interpretated respectivelly as proximal and distal floodplain deposits. 2) Green or black clays, depending on their organic matter content, deposited in marshes. 3) Nodulized and brechified marls and limestones of marginal lacustrine (palustrine) origin; these sediments are laterally related to 4) alternances of laminated limestones and marls deposited in the internal areas of the lake, far away from alluvial inputs. Siliciclastic inputs reached easily the lakes in those areas without marsh fringes. There, they were reworked and mixed with lacustrine faunas (ostracoda, foraminifera) and the sediments are alternances of carbonated sands and clays.

Sediments of both TSUs arrange in sequences of several orders. The simpler sequences (3rd order sequences, Mediavilla, in prep.) are 1 to 2 m thick and they are interpretated as due to the migration of two or more subenvironments (Fig. 7).

Cycles (4th order or composite sequences) are composed by several 3rd order sequences. From bottom to top they show sequences deposited in progressivelly more internal lacustrine areas (deepening-upwards) followed by an increase in siliciclastic sediments of fluvial or marginal lacustrine environments (shallowing-upwards). These are cycles related to subsidence pulses.

These cycles are grouped in two 5th order sequences characterized by the upwards thickening of the carbonate beds. The sedimentary break between these 5th order sequences records a depocenter shift that can be seen in all the basin center.

In all the basin center, lacustrine deposits of N3 TSU are expansive and they show a thickening upwards trend. This trend is interpretated as result of a decrease in uplift rates in the basin borders (decrease in siliciclastic input to the basin center) and a progressivelly more humid mediterranean climate that is confirmed by ecologic interpretation of faunas.

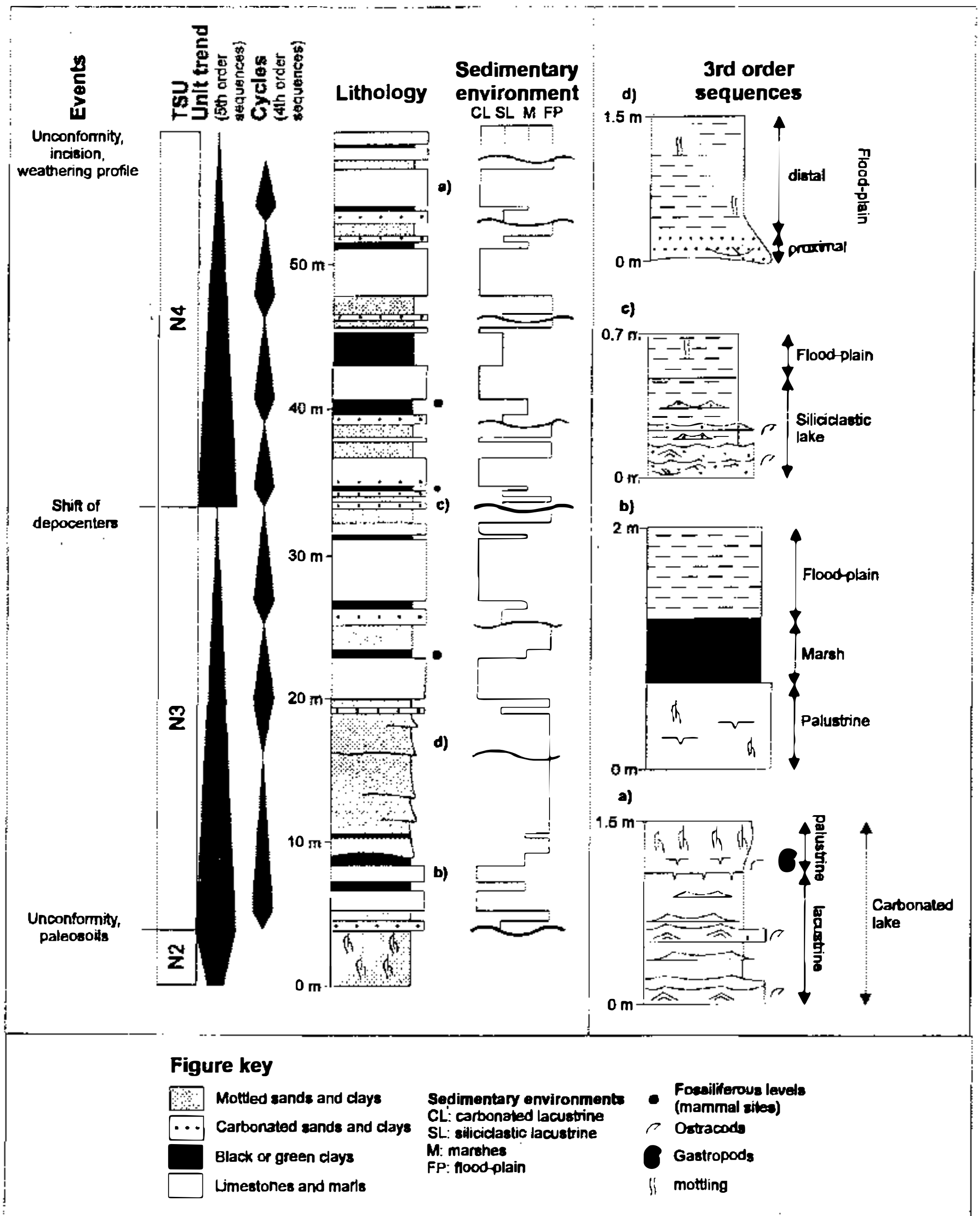

Fig. 7.- Stratigraphical section of Torremormojón.

N4 TSU is analyzed in Stop 2-2. We only remark that in this location it shows a similar trend that N3 TSU: an upwards thickening of the carbonate beds.

DAY 2

Stop 2-1. This stop locates at a gypsum quarry near Hornillo de Cerrato (Fig. 6). It is accesed via a local road that starts at the town.

The aim of this stop is to analyze the sequential arrangement of N4 TSU in a section composed by gypsum and carbonate. N5 TSU sediments are also analyzed. These are the first incised sediments in this area of the basin and they are Turolian, accordingly with mammal fossils (Santisteban *et al.*, 1997).

We notice two facts before starting with this stop:

1) A tectonic pulse took place after N4 TSU sedimentation. It generated NE-SW symmetrical folds, with vertical axial plane and 3 to 10 m of wave length, and asymmetrical folds related to normal and reverse faults.

2) A planation surface cut these tectonic structures coeval to N5 TSU sedimentation. A karst profile developed in relation to this surface. The original sediments, dolostones and gypsiferous rocks, suffered a transformation process to mesocrystaline limestones and marls with calcite pseudomorphs after gypsum similar to that described by Ordoñez *et al.* (1980). At the top of N4 TSU, micritic limestones show dissolution features, clay accumulation (*terra rossa*) and spherulites.

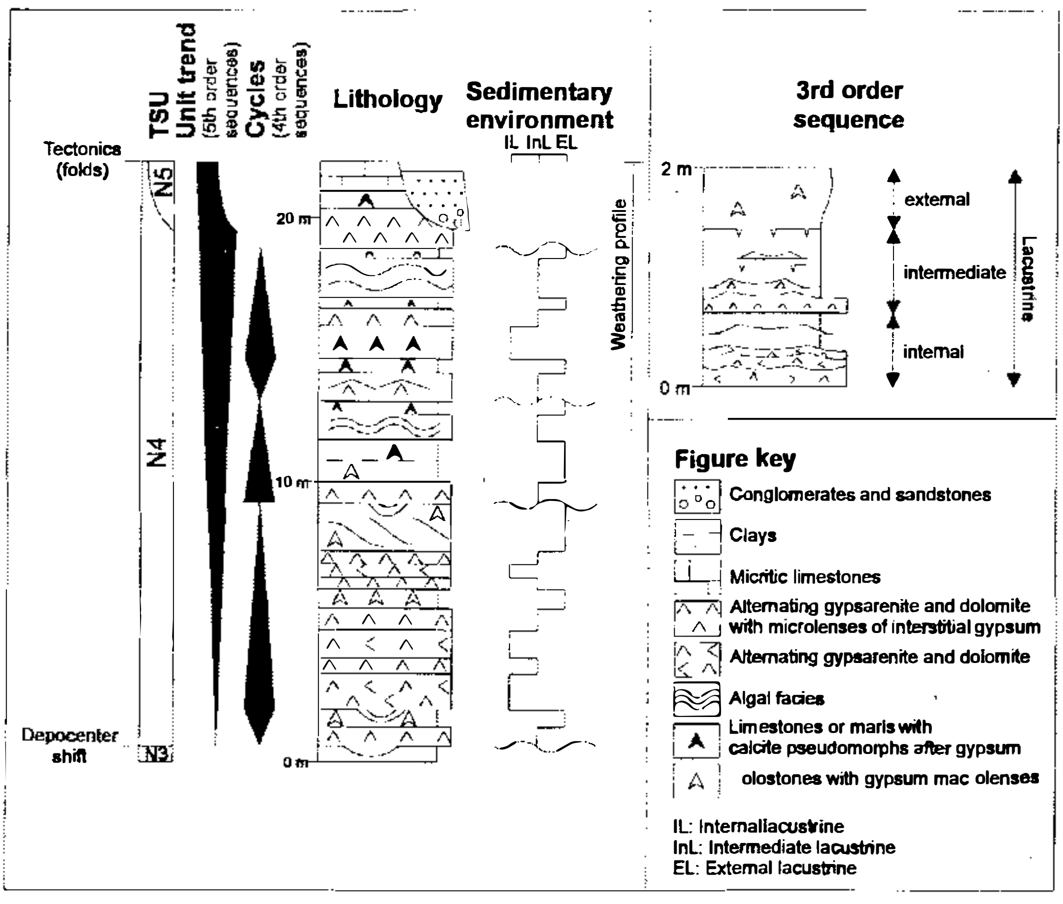

Fig. 8.- Stratigraphical section of Hornillos de Cerrato.

The lower bounday of N4 TSU is an erosive surface with multiple scours (channels) filled with green clays (maximum thickness: 0.5-0.75m). Gypsiferous-carbonated sediments are:

1) Cross-laminated gypsarenite and dolostones alternances that dispose upon flat or scoured surfaces (maximum depth of scours: 0.25 m). These sediments were deposited in internal lacustrine areas.

2) Cross-laminated gypsarenite and dolostones alternances with dessication cracks and microlenses of interstitial gypsum. Occasionally, these sediments enclose gypsarenite in tabular bodies of channel-shaped base interpretated as rill deposits. These sediments deposited in intermediate lacustrine areas.

3) Dolostones with micro- and macrolenses of interstitial gypsum deposited in external lacustrine areas.

4) To the top of the section, stromatolitic limestones, marls (dolostones and dolomitic marls before karstification) and clays deposited in intermediate lacustrine areas where waves didn't affect the bottom of the lake.

These sediments arrange in sequences of several orders (Fig. 8). The sediments of the simpler sequences (3rd order sequences) onlap the lake margin and they record the displacements of two or more subenvironments during two moments of minimum water depth; or in other words, a full cycle of deepening-shallowing in the lake. We consider that these 3rd order sequences are not controlled by climate (allocyclic control), as it is generally assumed, but they record the proper dynamics of the lake infill (autocyclic control).

Cycles (4th order sequences) are related to subsidence pulses, probably of tectonic origin. These cycles are bounded by erosive surfaces with multiple scours (channels) that were carved at maximum subsidence moments. Sediments, upon these surfaces, onlap the previous deposits. They record an episode in which the infill rates of the lake were higher than the subsidence rates. To the top of the cycles, sediments display prograding geometries towards the center of the lake. They record a period during which subsidence rates were greater than lake infill rates.

The 5th order sequence (N4 TSU) shows a shallowing-upward trend. This shallowing-upward sequence laterally changes to a deepening-upward trend (Stop 2-1). This situation is interpretated as due to a shift of lake depocenters related to tectonics.

Gravels and sands of N5 TSU rest discordantly and incised on N4 TSU deposits. They are affected by synsedimentary faults.

Stop 2-2. km 6,5 ZA 750 road (Pozoantiguo-Toro road) (Fig. 9). At the southernmost outcrops of the aggrading TSC C in the western Duero Basin, sediments of N2 TSU dip gently to the north and they onlap sediments of TSC B affected by the red weathering profile correlative to the deposits of N1 TSU.

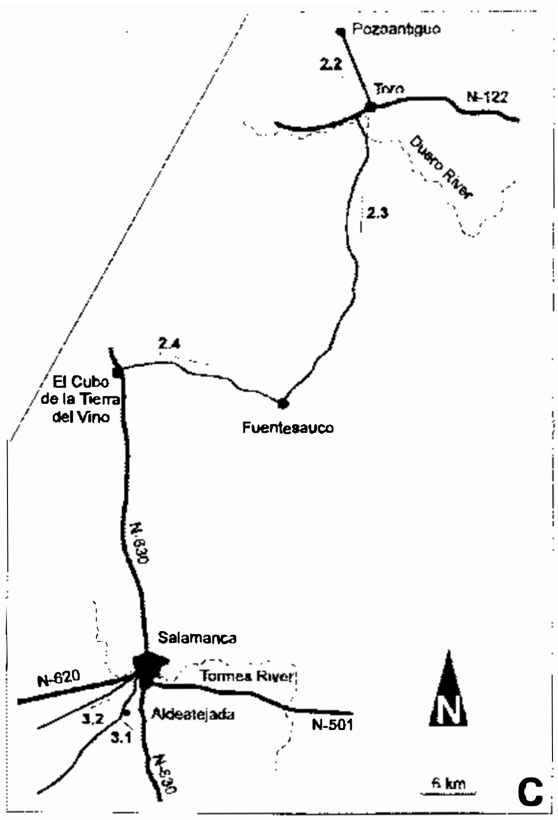

Fig. 9.- Geographical location of stops in the south-western border of the basin.

C) South-west border: This is a border of low uplift rates during all the Cainozoic, so all TSCs onlap it. However, the vicinity of the Central System (to the East and South), that experimented higher uplift rates and shortening during TSC B times, conditioned sedimentation in this area resulting in a coarsening-upward trend for this TSC.

On the other hand, this lower tectonic activity allowed the development, in all three TSCs, and preservation, only in A and C TSCs, of thick weathering profiles both in the accumulation basin and in the source areas. In any of these TSCs, climate signature can be also infered from sediments composition.

Finally, the reversal of the drainage, and the start of incision in this area, was during Oligocene-Lower Miocene times. From this time, incised network spread to the inner areas of the basin that were captured mostly from Middle Miocene times.

Stop 2-3. Panoramic view along Salamanca-Toro road, proximities of Vallesa de Guareña (Fig. 9). Panoramic view of TSC B sediments near the basin center.

TSC B sediments lying under TSC C are arkoses to litharenites of fluvial origin cemented by dolomite. These sediments are near horizontal and they are only affected by small displacement E-W normal faults.

Stop 2-4. Panoramic view along Fuentesauco-El Cubo de la Tierra del Vino road and detail of TSC B deposits affected by TSC C weathering profiles (Fig. 9).

a). The deposits all along this road belong to the P2 Unit (TSC B) and they show a near horizontal disposition that extends towards the western border of the basin (Fig. 10). This disposition is similar to that seen in Stop 2-3 but it is clearly different to the synsedimentary folding of TSC B sediments at the northern border of the basin (Stop 1-1).

Santisteban (1997) propose that this lateral variation of disposition is due to the differences in tectonic style and uplift velocity between south, north and west basin borders.

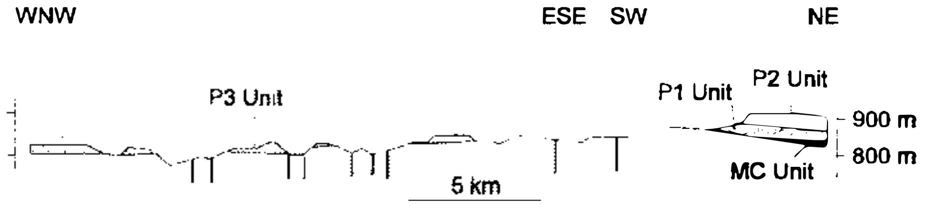

Fig. 10.- W-E cross-section showing the disposition of TSC B units upon western border of the basin.

The northern and southern borders are mountain chains related to N-S compressive stresses that caused shortening and high uplift rates. Reverse faults and thrusts in these borders caused synsedimentary shortening and the development of the progressive discordances like those seen in Stop 1-1.

On the other hand, the western border is characterized by extension and slower uplift rates linked to normal to strike-slip faults.

As result of these lateral differences in uplift rate and vertical *vs.* horizontal displacements, sediments of B TSC progressivelly onlap the western border while they offlap the northern and southern borders (Fig. 11).

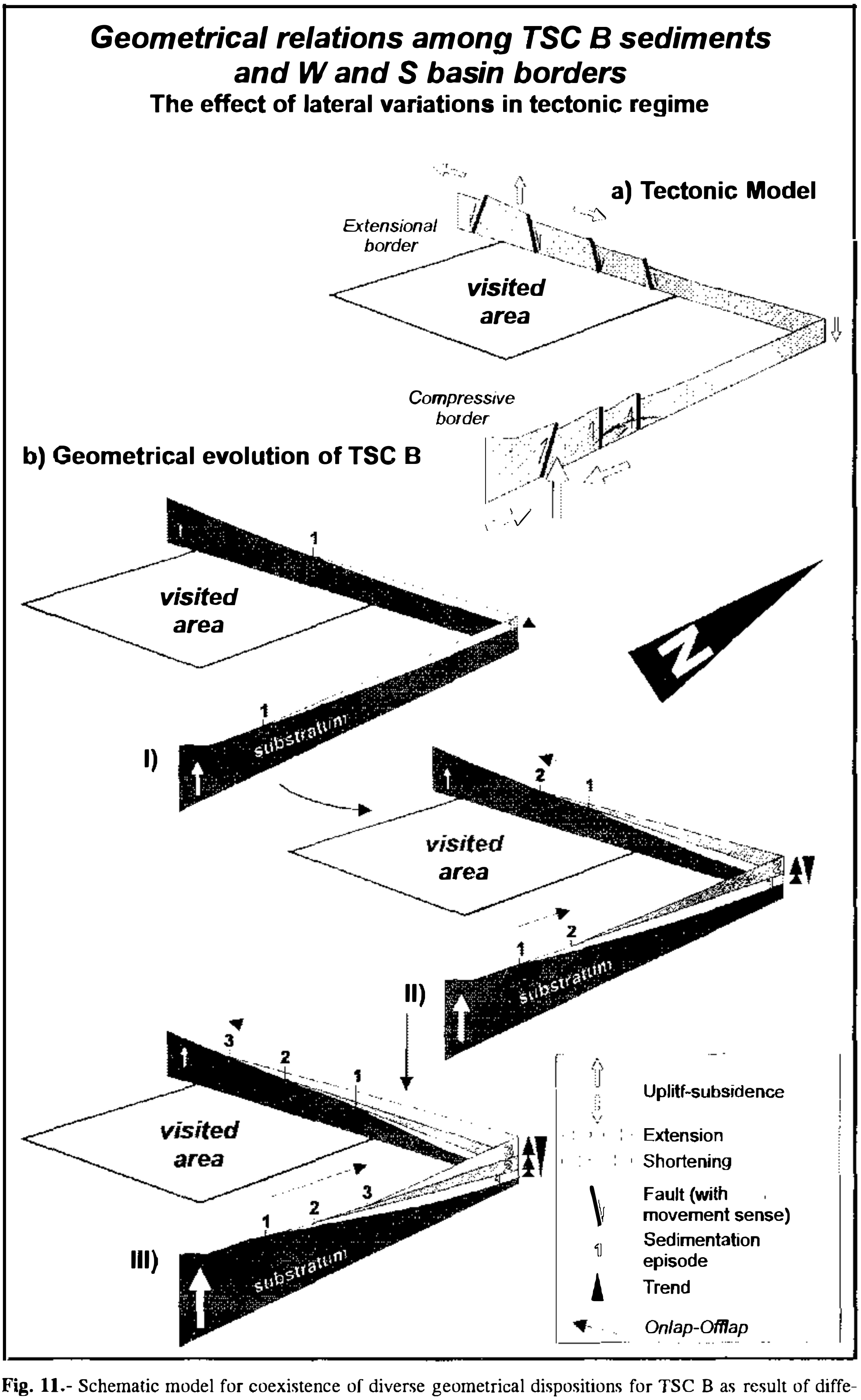

Fig. 11.- Schematic model for coexistence of diverse geometrical dispositions for TSC B as result of different behaviour of basin borders (modified from Santisteban, 1997).

b). The topographically uppermost sediments in this area are those of TSC B (P2 Unit). They form a topographical E-W height that reachs 926 meters above sea level. Here, sediments of P2 TSU, that outcrop at the base of the Losiles hill, are lithic arenites rich in feldspar with smectitic matrix and cemented by dolomite. They were deposited under arid subtropical climate. They are affected by weathering profiles, developed under mediterranean climate, correlative to TSC C deposits. Argilization and reddening imprint in these material an external look similar to that of lowermost unit of the TSC C (N1 Unit). Goethite formation (ochre colors) and kaolinite neoformation in higher porosity areas (roots, cracks) reveal later TSC C weathering processes acting on this area (correlatives to N2 to N5 units). Finally, leaching zones (white colour) show us the youngest weathering processes developed during Quaternary. This sequence of weathering profiles indicates that no sedimentation took place in this area since, at least, Oligocene times and, therefore, it never was buried.

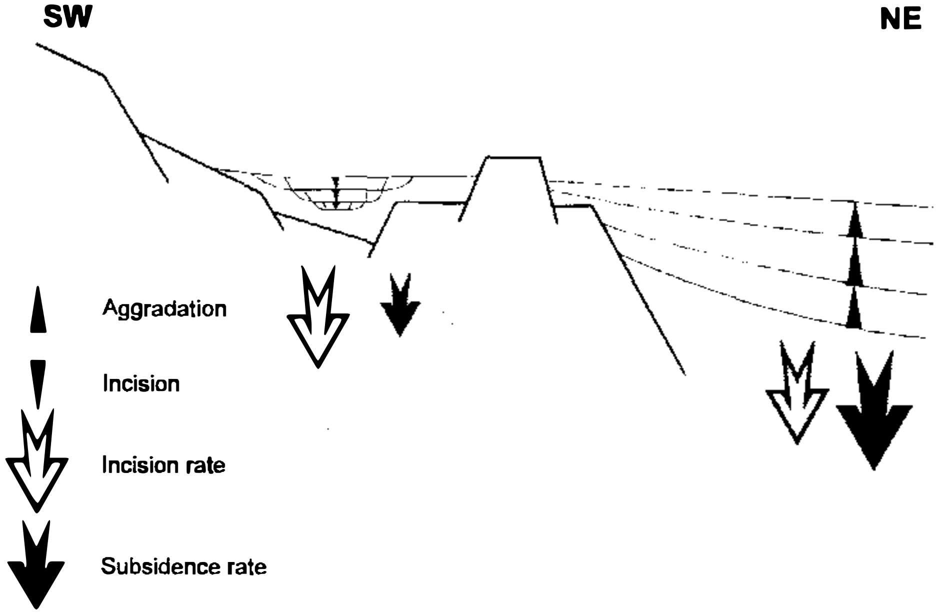

Fig. 12.- Coeval incision and aggradation as result of lateral variations in the relation of subsidence *vs.* incision rates (after Santisteban *et al.*, 1996b).

This height separates the aggradative Neogene Duero Basin (to the North, Stops 1-2 to 2-4) to the deggradative one. It acted as a geographical threshold that separates zones with different subsidence rates. Therefore, subsidence rate was greater than incision rate to the north, allowing aggradation during Neogene times, whereas to the south that rate relation reverse and incision dominated during Neogene times (Fig. 12; Mediavilla *et al.*, 1996; Santisteban *et al.*, 1996b).

DAY 3

Stop 3-1. Hill east to Aldeatejada (Fig. 9). Observation of TSC A weathering profiles and deposits and its disposition upon south border metasediments.

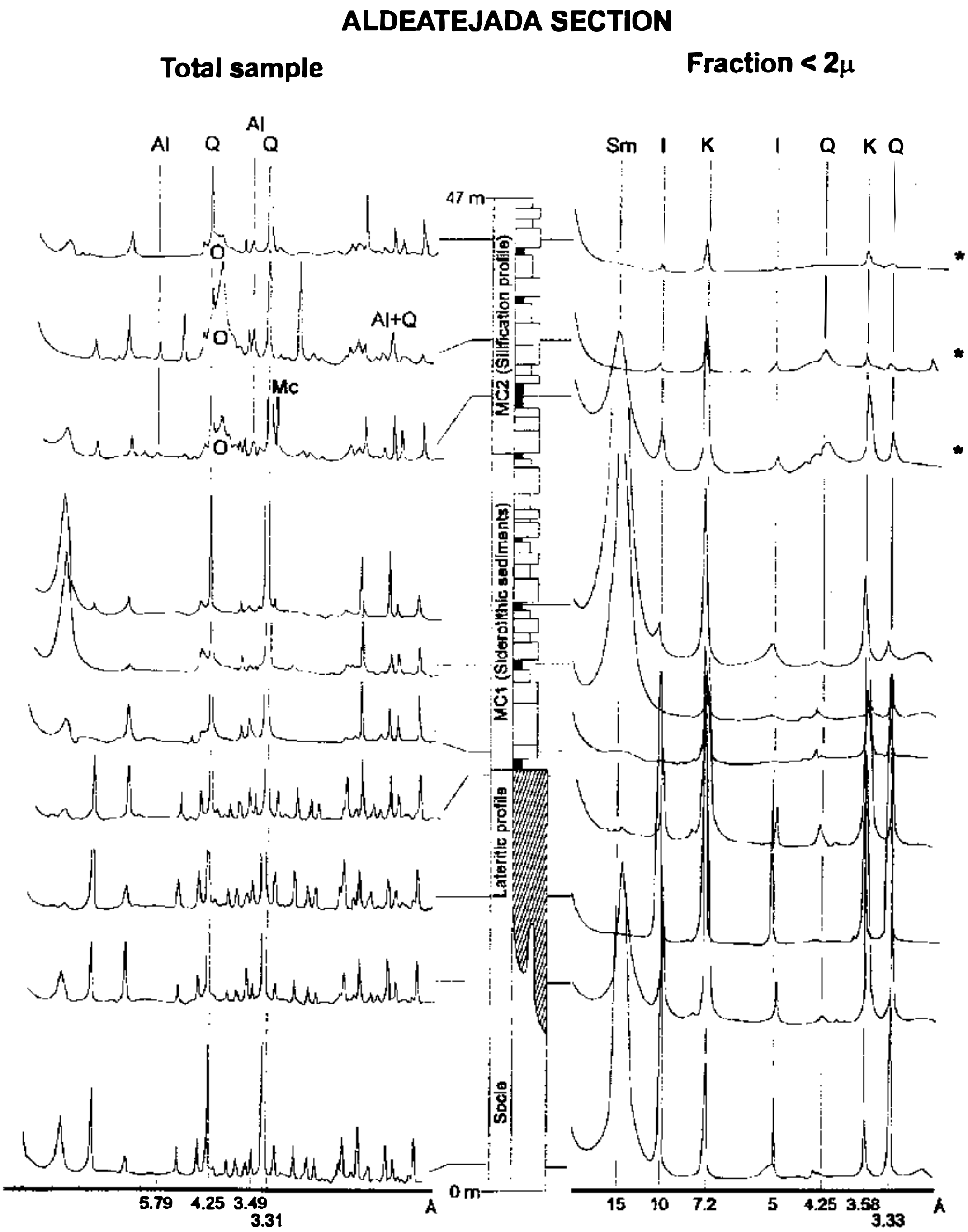

Fig. 13.- TSC A (MC Unit) section in Aldeatejada and mineralogical composition. This section includes the lowermost weathering profile of the western border of the basin and the silicification profile that marks the end of this TSC.

The firsts post-Paleozoic deposits of western Duero Basin are those of TSC A (Fig. 13). TSC A is near horizontal at this location, near the southern and western borders of the basin, so we can infer that no shortening tectonics acted since Late Cretaceous times in this area.

The TSC A succession begins with a lateritic profile developed on the Paleozoic metasediments. We can distinguish two horizons in this profile:

a) At the bottom, chlorites and biotites of the metasediments were depleted of iron that repreci-pitated as oxides. Part of this micas start to transform to smectites and kaolin. The rock has red-purple, brown and white colours but the structure of the fresh rock (schistosity and bedding) is well-preserved.
b) To the top, iron has been completelly depleted and transformation to kaolin reachs their maximum. So, the rock became a white clayey level in which it still is possible to see part of the original structure.

The sediments resting upon this profile share their mineralogical composition with it. They are kaolin-rich quartz-arenites with some iron oxides and they are interpretated as braided fluvial deposits (Alonso Gavilán, 1981; Santisteban, 1997).

To the top of the TSC, deposits of TSC A, in overall, of finer grain size of braided fluvial origin, but with a progressive increase in width and flood-plain development. These sedimento-logical changes are interpretated as the concurrent burying of paleovalleys (onlap of the border) and a decrease in their depositional slope. Simultaneously to these sedimentological changes, the sediments become strongly silicified, so the top of the TSC became an erosive-structural surface.

Both lateritic and silicification profiles reveal a hot climate with seasonal rains similar to present-day climate in ecuatorial to tropical (moonson) areas.

Stop 3-2. Road cut along Salamanca-Matilla de los Caños road (Fig. 9), west to the Montalvos mount. Relations between erosive terraces, weathering profiles and deposits inside TSC C.

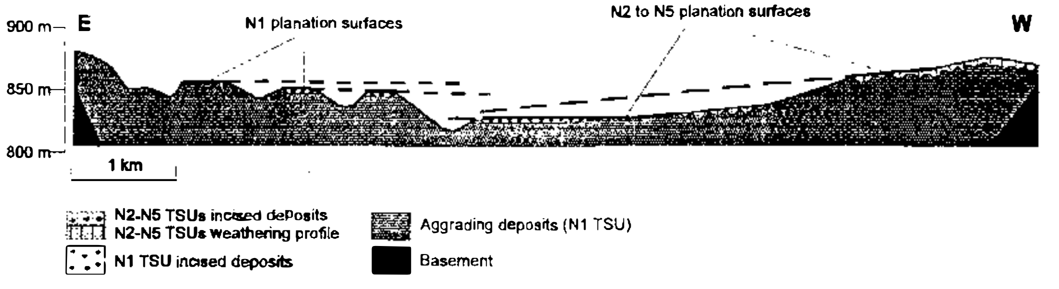

Fig. 14.- Geological cross-section of TSC C sediments along the Salamanca-Matilla de los Ca-ños road.

TSC C along southern and southwestern border is characterized by the scarcity of deposits that mainly belong to N1 TSU. Weathering profiles and planation surfaces, on the other hand, are widespread distributed. Relations between weathering profiles, planation surfaces and depo-sits reveal that most of TSC C developed under an incision regime, so as younger the sediment more lower it locates.

In other order, the main criteria to identify TSU boundaries in this area is the change in their mineralogical composition and colour (N1 TSU is red -hematite- and clays are dominated by illite-kaolinite; N2 to N5 TSUs are ochre -goethite- and dominated by kaolinite-illite). So climate, varying from arid mediteranean during N1 TSU times to humid mediterranean during N2 to N5 times, overcame tectonic signal as result of the slow rates of tectonic movement that allowed a good development of weathering profiles.

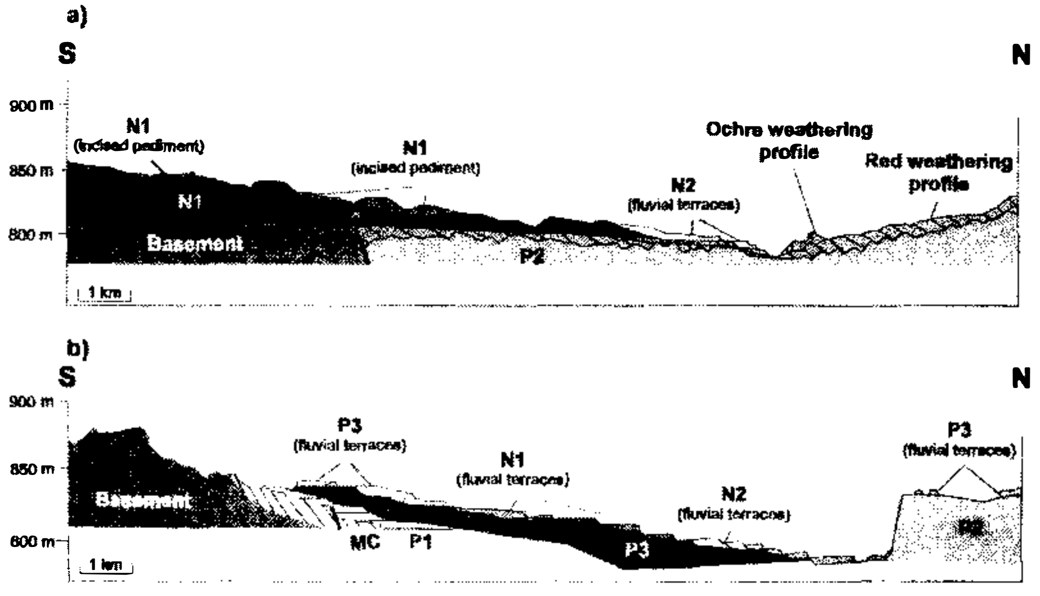

Fig. 15.- S-N geological cross-section showing the relations among TSC C and TSC B units. Section a) is perpendicular to Fig. 14. Section b) is located 15 km eastward.

Along the road from Salamanca to Matilla de los Caños we can see (Fig. 14) 1) aggrading red sediments that belong to N1 TSU; these deposits are mainly clays with some gravel levels interpretated as alluvial fan deposits (Santisteban, 1997). 2) Incised red deposits of N1 TSU that are gravels corresponding to thin alluvial fans (*glacis* or pediment deposits) and of fluvial origin (terraces). 3) Ochre weathering profiles, correlative to N2 to N5 TSUs, affecting N1 TSU deposits. 4) Incised ochre sands of fluvial origin (terraces near the present-day river courses) that record N2 to N5 TSUs.

One peculiarity of this area is that part of N1 TSU sediments are still aggrading (Fig. 14, Fig. 15a) while in near areas (to the East) all deposits since the end of TSC B are incised (Fig. 15b). Correlation between aggrading and incised deposits (Fig. 16) is explained as due to variations in subsidence *vs.* incision rates, like in Stop 2-4 B (Fig. 12).

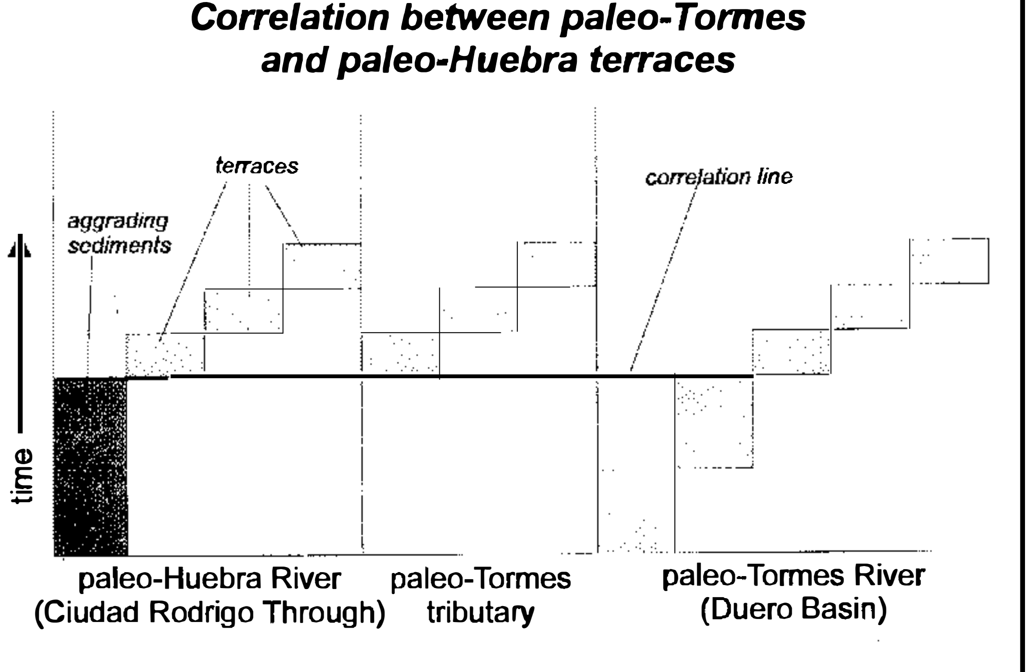

Fig. 16.- Correlation between aggrading and incised deposits at the bottom of TSC C (after Santisteban, 1997). The coexistence of both types of deposits is related to tectonics, as it was explained in Stop 2-4 (Fig. 12).

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